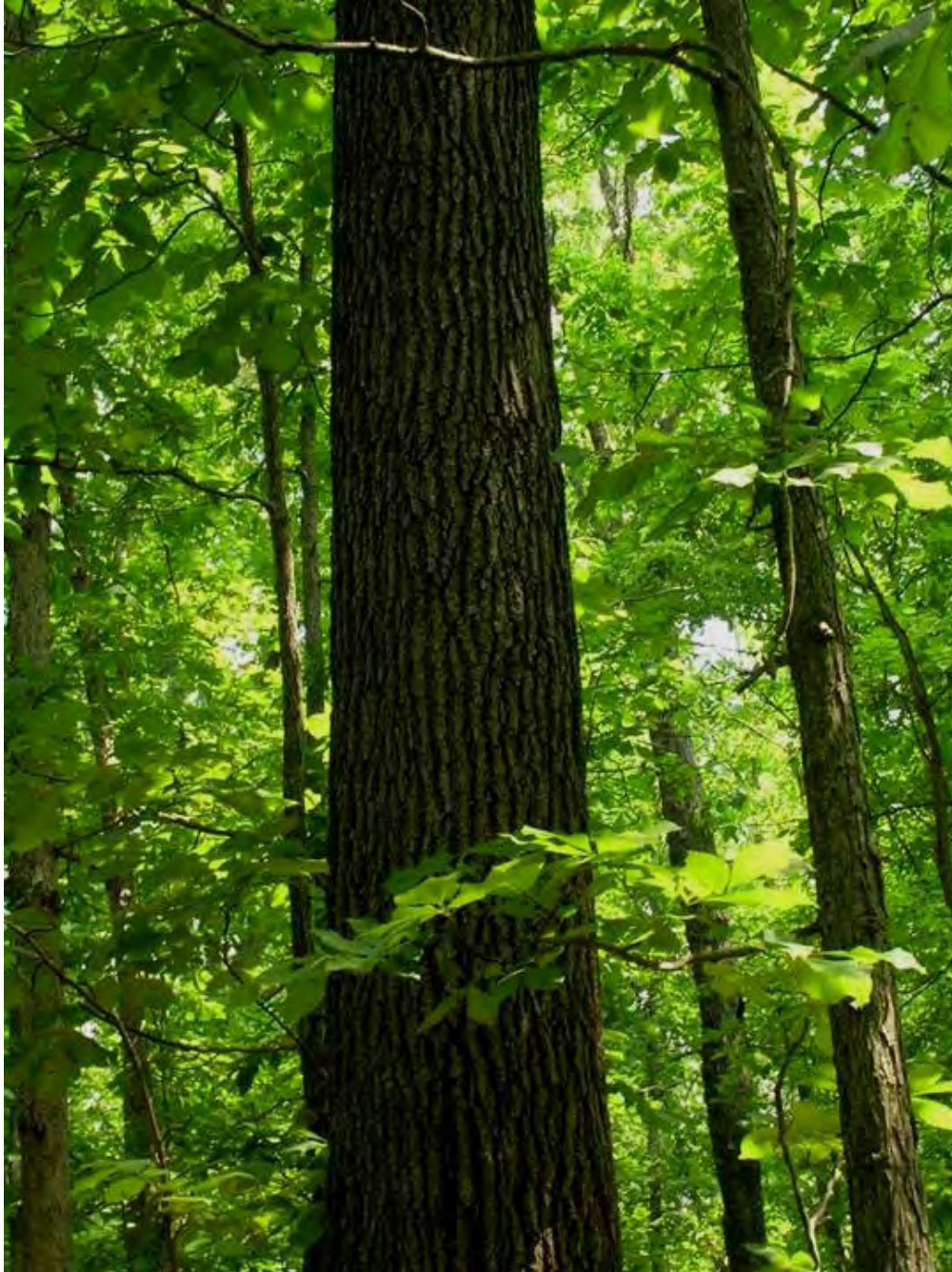


# **FORESTRY FOCUS**

## **2007 Forestry Related Research Annual Report**



Peck Ranch CA, Meg Timpe

**March 2008**  
**Resource Science Division**  
**Missouri Department of Conservation**

## Executive summary

*Forestry Focus* is our new annual report of forestry-related research by the Resource Science Division of the Missouri Department of Conservation. The purpose of *Forestry Focus* is to annually report on accomplishments and on-going research initiatives. This issue of *Forestry Focus* represents the first time that all forestry-related research studies have been brought together in a single document. The report was designed for MDC resource managers, but should also be of interest to the general public and other land managers. It provides an insight into current and proposed research in support of sustainable and healthy forest communities.

We provide brief descriptions for 41 studies conducted in 2007 or planned for 2008. We also provide a link for more information and/or an email address for the main contact person.

These studies encompass community restoration, ecosystem management, fire ecology, forest economics and forest health. These comprehensive studies support MDC's Next Generation goals:

- Conserving plants, animals and their habitats
- Protecting clean and healthy waters
- Promoting healthy trees and forests

Technology transfer was central to the Resource Science Staff activities during the year. It was accomplished through conferences, workshops, sciences notes, other in-house publications and peer-reviewed journals, thereby promoting the relevance of research to resource managers and the public.

We conducted our research in collaboration with hundreds of resource managers and scientists from 16 state and federal agencies, and universities within and outside the state.

We welcome your feedback and ideas for improving *Forestry Focus* or on research initiatives, and look forward to working with you in the coming year.

2007 *Forestry Focus* Committee:

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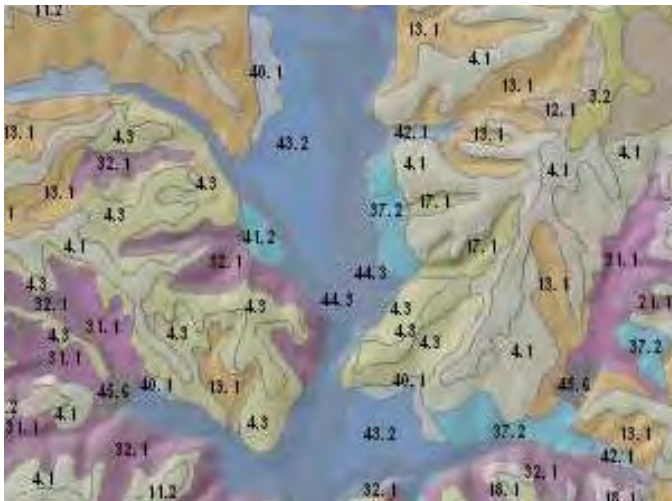
# Ecological Landtype Mapping

## Missouri Statewide Ecological Landtype Definitions and Maps

*Project leader:* Tim Nigh

*Collaborators:* Jeremy Kolaks (MDC), David Diamond (MoRAP), Fred Young (NRCS), Dennis Meinert (DNR), Doug Wallace (NRCS)

*Objectives:* To define and map Ecological Landtypes for all Missouri subsections starting with the soil survey.



Landscapes are being broken into site or stand level landtypes using the soil survey as a starting point

*Summary of activities/findings in 2007:* Three pilot subsections were completed this year, the Chariton River Hills, the Outer Ozark Border, and the Springfield Plateau. Reports will be available by April 1, 2008. They will include definitions and diagrams of all ELTs in each subsection and a DVD with Arc GIS project set up to access ELT and related maps.

*Plans for 2008:* We will complete office, field and reporting for 10 subsections in northern Missouri.

*For more information:*

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# Shortleaf Pine Natural Communities

## Underplanting shortleaf pine

*Project leader:* Jason Jensen (MDC)

*Collaborators:* David Gwaze (MDC), Cliff Smith (USDA Forest Service), Mark Johanson (MDC)

*Objectives:* The objectives of the study were: 1) to compare stocking and growth of shortleaf pine seedlings planted underneath various overstory densities, and 2) to evaluate influence of hardwood competition on growth and stocking of underplanted shortleaf pine seedlings.

*Summary of activities/findings:* Shortleaf pine seedlings were underplanted at Clearwater Conservation Area in mature mixed oak and oak/pine stands. Overstory trees were harvested a few months after planting. The different overstory treatments included 1) unevenaged management with group openings, 2) clearcut, 3) overstory reduction to B-level stocking and 4) overstory reduction to C-level stocking. Seven years after treatment application, clearcut stands had the best stocking and growth of planted shortleaf pine seedlings (Fig 1). The clearcut stands also had the highest number of free-to-grow seedlings. Group openings established in uneven-aged management treatments appear to work, but the results suggest that they should be much larger to effectively regenerate pine.

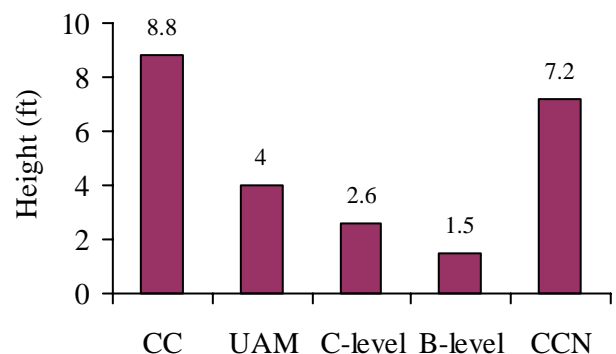


Figure 1. Height growth of shortleaf pine trees 7 years after establishment at Clearwater Conservation area. CC =clearcut and planting; UAM = unevenaged mgmt and plant; C-level = thin to C-level stocking and plant, B-level = thin to B-level stocking and plant; CCN = clearcut and no planting. Numbers on bars are treatment means.



Growth of natural advance reproduction while in the understory, and released after clear cut harvesting was similar to growth of underplanted shortleaf pine seedlings and released after clearcut harvest, seven years after planting. This suggests that underplanting was effective in allowing planted pine seedlings the time to become established and, therefore, the capability of responding once released.

Findings of this study suggest that clearcutting is the best method of regenerating pine, and that the higher the stocking rate of the residual overstory, the poorer the growth and stocking of the underplanted seedlings. The results also suggest that retaining the overstory for seven years adversely affects stocking and growth of shortleaf pine seedlings and, thus, early release of underplanted seedlings is likely to result in a greater increase in stocking and growth.

*Plans for 2008:* Plans include developing a proposal to examine the effects of removing overstory trees on survival and growth of the 10-year-old underplanted shortleaf pine trees.

*For more information:*

[Jason.Jensen@mdc.mo.gov](mailto:Jason.Jensen@mdc.mo.gov)

Jensen, J., Smith, C., Johanson, M., Gwaze, D. 2007. Underplanting shortleaf pine in the Missouri Ozarks. In: Kabrick, J. M. Dey, D.C., Gwaze, D., eds. Shortleaf pine restoration and ecology in the Ozarks: proceedings of a symposium; 2006 November 7-9; Springfield, MO. Gen. Tech. Rep. NRS-P-15. Newtown Square, PA: USDA Forest Service, Northern Research Station: 112-116.

## **MIDCO Pine Flats Restoration**

*Project Leader* – Carrie Steen (MDC)

*Collaborators* – Mike Norris, David Gwaze and Mike Wallendorf (MDC); John Kabrick (USDA Forest Service)

*Objectives:* To determine the type, extent, and timing of release required to ensure shortleaf pine seedlings will become a component of the overstory.

*Summary of activities/findings:* Two herbicide treatments were conducted in late summer 2006. With the help of another crew in 2007, we were able to collect first year post-treatment data that had

not initially been planned. Forestry and Wildlife managers also conducted a prescribed fire in one of the fire treatment only areas.

*Future plans:* Data will be collected again in 2009.



*For more information:*

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Steen, C., K. Houf and M. Norris. 2007. Shortleaf Pine Community Restoration and Monitoring. Missouri Department of Conservation Science Notes Vol. 2, No. 5

## **Long-term soil responses to site preparation ripping**

*Project leader:* David Gwaze (MDC)

*Collaborators:* Mark Johanson (MDC), Carl Hauser (retired)

*Objective:* To evaluate the effects of a March 1988 ripping study at Logan Creek CA on soil chemical and physical properties, on free-to-grow status, and on survival and growth of planted shortleaf pine seedlings.

*Summary of activities/findings in 2007:* After 16 years, ripping increased exchangeable calcium; however, it had no long-term effects on soil particle size, organic carbon, pH, exchangeable potassium and exchangeable magnesium. The depth to and thickness of fragipan was similar in the ripped and control treatments. Average depth to fragipan was 20 inches and average fragipan thickness was 20 inches. These results indicate that ripping at 24 inches would not have broken the fragipan. To break the fragipan at this site, a ripper with teeth at least 40 inches long would be required. This would have increased the costs of site preparation

substantially. Ripping increased pine survival and growth at ages 1-3. At age 16, ripping no longer had an effect on height and had reduced diameter by 5.3% and volume by 11.0%. Our results suggest that ripping 1) had no effect on long-term physical properties or chemical properties of the soil, 2) had no effect on the number of free-to-grow seedlings, and 3) produced short-term benefits on survival and growth of planted shortleaf pine. The lack of benefits from long-term ripping is likely attributed to the ripping depth not breaking the fragipan.

*For more information:*

[David.Gwaze@mdc.mo.gov](mailto:David.Gwaze@mdc.mo.gov)

Gwaze, D., Johanson, M. and Hauser, C. 2007. Long-term soil and shortleaf pine responses to site preparation ripping. *New Forests* 34: 143-152.

### **Establishing and recruiting pines and oaks in declining oak stands**

*Project leaders:* David Gwaze, Tom Nichols(MDC)  
*Principal Investigators:* John Kabrick, Dan Dey (USDA Forest Service), Carrie Steen, David Gwaze (MDC)

*Objectives:* 1) To determine the best method for establishing and recruiting pine-oak mixes using a combination of designed experiments and data from existing studies. 2) To develop these findings into management guidelines. This study comprises five component studies and objectives.

*Summary of activities/findings in 2007:* Two direct seeding tests were assessed. Elizabeth Blizzard, a Ph.D. student, completed a manuscript on shortleaf pine recruitment based on data collected at the Houston/Rolla district of the Mark Twain National Forest (published in the proceedings of the shortleaf pine symposium). Her results showed few differences in the density or height of pine reproduction among burn or scarification treatments. Stands that were scarified or burned had pine reproduction averaging 1.7 feet tall, about 15% shorter than stands that were not burned or scarified. However, the growth of the pine reproduction varied significantly within stands depending on the surrounding overstory basal area and on the height of competing hardwoods in the understory. The growth of the pine reproduction

decreased with increasing overstory basal area and increased with increasing height of competing hardwoods. Also, pine reproduction that was codominant or dominant to cohorts (competitors) was about 4.5 to 5.5 feet tall, respectively, and grew two times faster than those that were intermediate or suppressed. However, only about 28% of the pine reproduction was in dominant or codominant crown classes and the average height of the nearest competitor was 7.8 feet, nearly 2 feet taller than the average dominant pine. The probability that pine reproduction was dominant or codominant decreased markedly as the number of oak and other hardwood competitors increased in density or height.

One study was established in compartment 6 (stands 1, 2 and 14) at Logan Creek CA to quantify oak colonization of shortleaf pine stands established with artificial regeneration methods. Twelve plots (each 0.25 ac~ 100 x 100 ft) evaluating 4 thinning treatment levels and unthinned controls were established. Plots were thinned to 0%, 30%, 50% and 70% of the unthinned controls. Pre-treatment data were collected.

*Plans for 2008:* The direct seeding studies and the oak colonization studies will be assessed.

*For more information:*

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### **Evaluation of performance of shortleaf pine provenances**

*Project leader:* David Gwaze (MDC)  
*Collaborators:* Jenny Myszewski, John Kabrick (USDA Forest Service)

*Objectives:* To evaluate the performance of seed sources from across the natural range of shortleaf pine to determine which sources are best adapted to the environmental conditions in Missouri. The stability of provenance performance across ages was also examined.

*Summary of findings:* Two shortleaf pine provenance tests established by the USDA Forest Service Northern Research Station as part of the South-wide Southern Pine Seed Source Study were examined to determine the most suitable seed

sources for planting in Missouri. Each test contained 7 different provenances from 6 or 7 states in the natural shortleaf pine distribution. Significant provenance differences in survival and height growth were found in both tests, and a strong north-south trend was observed. Northern sources (New Jersey and Tennessee provenances) had the best survival (Fig. 2) and greatest height growth while southern sources (Georgia and Louisiana) had the poorest survival and lowest height growth.

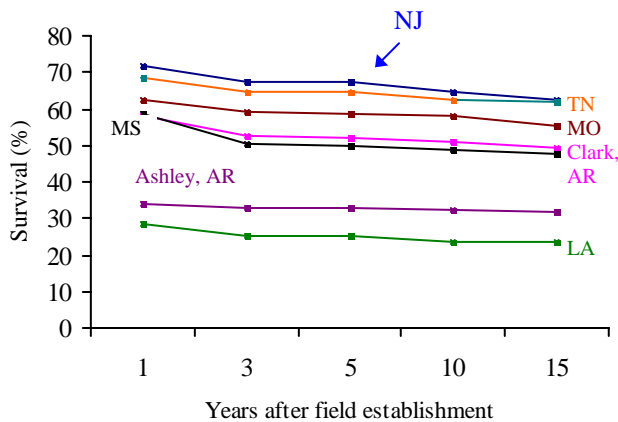


Figure 2. Survival of shortleaf pine provenances.

Regression estimates of slope indicate that New Jersey and Tennessee provenances have the highest relative growth rates. Both survival and height were highly correlated with latitude and annual mean temperature at the seed source. Results from this study suggest that the best seed sources for planting in central Missouri are not those from Arkansas as current practice suggests but instead sources from states in the northern portion of the natural shortleaf pine distribution.

*For more information:*

[David.Gwaze@mdc.mo.gov](mailto:David.Gwaze@mdc.mo.gov)

Gwaze, D., Myszewski, J. and Kabrick, J. 2007. Performance of shortleaf pine provenances in Missouri. In: Kabrick, J. M. Dey, D.C., Gwaze, D., eds. Shortleaf pine restoration and ecology in the Ozarks: proceedings of a symposium; 2006 November 7-9; Springfield, MO. Gen. Tech. Rep. NRS-P-15. Newtown Square, PA: USDA, Forest Service, Northern Research Station: 89-94.

## Genetic variation and population structure in shortleaf pine

*Project leader:* Jeff Koppelman (MDC)

*Collaborators:* Emily Parsons, Briedi Scott, Jennifer Collantes, Lori Eggert, David Gwaze (MDC), Sedley Josserand, Craig Echt, Dana Nelson (USDA Forest Service), Hank Stelzer (MU)

*Objectives:* The objective of this study was to evaluate the genetic diversity among Missouri shortleaf pine populations using microsatellite genetic markers.



*Summary of findings:* Genetic diversity in the form of SSR (microsatellite) allelic variation was documented for shortleaf pine growing in 4 stands in east-central and southern Missouri. Those stands were selected on the basis of (1) possessing a high abundance of large shortleaf pine trees and, hence, assumed to be natural rather than planted; and (2) representing the extent of geographic distribution of the species in Missouri. Preliminary results show that substantial genetic diversity still exists in shortleaf pine, and most genetic diversity is within populations. Genetic differentiation among shortleaf pine populations was not apparent. We explored the relationship between genetic and geographic distance, but it was difficult to conclude that a relationship exists due to few data points.

*Plans for 2008:* we will sample more stands and examine contamination of the Mt. Ida seed orchard and level of genetic diversity within Missouri seed stock.



*For more information:*

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Koppelman, J., Parsons, E., Scott, B., Collantes, J., Eggert, L., Josserand, S., Echt, C., Nelson, D. 2007. Phylogeographic analyses and evaluation of shortleaf pine population structure in Missouri. In: Kabrick, J. M. Dey, D.C., Gwaze, D., eds. Shortleaf pine restoration and ecology in the Ozarks: proceedings of a symposium; 2006 November 7-9; Springfield, MO. Gen. Tech. Rep. NRS-P-15. Newtown Square, PA: USDA Forest Service, Northern Research Station: 104-104.

## **Landowner attitudes toward shortleaf pine restoration**

*Project leader:* David Gwaze (MDC).

*Collaborators:* Heather Scroggins, Tom Treiman, Ron Reitz, Michelle Baumer (MDC)

*Objectives:* To assess private landowner attitudes, understanding and awareness of shortleaf pine restoration. The more specific objectives were to: understand the views of private landowners on shortleaf pine restoration, and explore the main socio-economic factors affecting private landowners' perceptions of shortleaf pine restoration.

*Summary of activities in 2007:* Private landowners were selected for participating in focus groups using data from the George O. White Nursery plus information provided by the Private Land Services Division staff. Focus groups were held April 14, 2007 at Rolla and Houston, and May 19, 2007 at Eminence and West Plains. At each venue, private landowners were split into two groups - one consisting of those that had restored shortleaf pine and the other consisting of those that had not. Each group numbered 6-12 people.

*Plans for 2008:* Data will be analyzed and a report will be written on the findings. Results from the focus groups will be used to develop a mail survey.

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## **Bottomland Forest Natural Communities**

### **Riparian Reforestation Management Evaluation**

*Project leader:* Randy Jensen (MDC)

*Collaborators:* David Rowold, Brian Hall, Marty Calvert, Mark Johanson, Nate Forbes, Mike Wallendorf, Brad Pobst, Paul Blanchard, Greg Hoss (MDC), John Kabrick, Dan Dey (USDA Forest Service)

*Objectives:* To compare the growth and survival of planted tree seedlings in riparian zones using a variety of tree species and planting treatments. To compare the ground flora and natural regeneration response to different tree planting treatments. And, to compare the costs associated with these different treatments.



*Summary of activities/findings in 2007:* On a replicated experiment for a Masters study, Kyle Steele and crew re-measured planted seedlings (13 species) in 5 different planting treatments on three different sites, after 2 growing seasons. Ground flora, natural regeneration, and horizontal foliar coverage data were also collected.

On the ME portion of the study, initial tree and ground flora data was collected on 2 new tree plantings. Ground flora data was collected on 3 sites that were planted in 2005. Seedling data was collected on another site planted in 2006.

*Plans for 2008:* Seedling growth and survival data will be collected after 2 growing seasons on the

2007 plantings at 3 sites. Ground flora and natural regeneration data will be collected after 3 growing seasons on the 2006 plantings at 5 study sites.

*For more information:*

[Randy.Jensen@mdc.mo.gov](mailto:Randy.Jensen@mdc.mo.gov)

## **Review of Bottomland Forest Management Activities and Recommendations for MDC Areas near the Mississippi and Missouri Rivers**

*Project leader:* Dawn Henderson (MDC)

*Reviewers:* Robert Hrabik, Ron Dent, David Gwaze, Mike Anderson, Lonnie Messbarger (MDC)

*Objectives:* To better understand MDC efforts toward restoration, reforestation, and afforestation (establishing forest on previously unforested areas or areas that haven't been forested recently) along the Mississippi and Missouri Rivers, a request for information was sent to MDC area managers regarding their involvement (i.e., extent and number) in tree planting projects along these rivers. The focus of the questionnaire was tree planting efforts occurring after the floods of the 1990's.



Jim Rahtert

*Summary of activities/findings in 2007:* After having completed this retrospective and reviewing current literature, a few important issues appear reoccurring and must be brought to bear in future research and ME projects. First, it appears that matching tree species to edaphic conditions can be paramount in meeting with successful regeneration, restoration, reforestation, and afforestation efforts. Conditions that are difficult or impossible to control such as temperature, hydrology, light levels, soil pH, and structure must be considered. Additionally, species silvical characters must be matched with these conditions.

Secondly, single species plantings appear to have lower performance as well as adding little to species or structural diversity to altered floodplain forests. Mixed species plantings appear to offer a wider use of above and below ground growing space. Additionally, the crown architecture, branching patterns, fruiting patterns, and overall benefit to a wide range of wildlife appears to be best mimicked with mixed species plantings.

Lastly, further study is needed to determine why the most cost effective method of restoration, reforestation, and afforestation is direct seeding, yet is also the least reliable. Questions still remain regarding the link between “good” acorn crop production and lack of natural regeneration seen in bottomland forests as well as the length of time needed for germinates to reach the minimum size/age class to successfully compete for resources. Defining the requirements for successful acorn germination will be paramount.

*Plans for 2008:* Project completed.

*For more information:*

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## **Next Generation of Forests on the Upper Mississippi River Floodplain**

*Project leader:* Yao Yin (USGS)

*Collaborators:* Dawn Henderson (MDC), Eileen Kirsch (USGS), Gary Swenson (USACOE)

*Objectives:* The forest we witness today on the floodplain of the Upper Mississippi River is the product of intensive anthropogenic activities that included logging, conversion of prairie/forest land to farmland and then reforestation, and altered surface and underground hydrology. A major portion of the forest was established after the installation of the navigational lock and dam system during the 1930s and 1940s. Compared with its historical counterpart, today's forest consists of fewer flood-intolerant species, especially mast-producing oaks and hickories, and exhibits less age differentiation between stands.

Given the slow rate of forest succession process, remedies have to take place decades prior to the arrival of crisis. Forest restoration projects require scientific prediction of the species composition of

the next-generation forest in 50 years under the assumption of natural regeneration. The flood of 1993 reset the clock of forest succession, and in 1995, the LTRMP (Long Term Research Monitoring Program) conducted an initial survey of forest composition. Based on these data, preliminary predictions of forest successional trajectory were identified. A test of the predictions using new data will demonstrate science leadership and responsibility of the LTRMP.

*Summary of activities/findings this year:* The project is completed and a peer-review manuscript is being developed by: Yao Yin (USGS), Jim Rogala (USGS), Dawn Henderson (MDC), Rob Cosgriff (INHS), Joe Lundh (COE), and Pat Heglund (USGS).

*For more information:*

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### **Vegetative Indicators of the Upper Mississippi River Floodplain Ecosystem**

*Project leader:* Loretta Battaglia (SIUC)

*Collaborators:* Valerie Barko (Departed MDC) and Dawn Henderson (MDC).

*Objectives:* The goal of this project is to develop biological indicators for floodplain wetlands using structural and functional attributes of floodplain vegetation. Specific objectives include 1) development of vegetation-based indicators of floodplain condition using data collected from bottomlands located between Cairo, IL and Quincy, MO; and 2) field-testing the utility of these indicators for assessing bottomland forest integrity across the lower UMRS (IL and MO).

*Summary of activities/findings in 2007:* We successfully established a network of permanently marked plots for quantifying the ecological condition of MRS floodplains bordering Missouri and Illinois. These plots provided baseline data and can be used in the future for monitoring and assessing response to management and future restoration measures. We also met our primary research objective of identifying indicators that are useful for evaluating floodplain condition. The variables measured on these plots provide a suite of ecological diagnostics for evaluating the MRS floodplains bordering Missouri and Illinois.

*Plans for 2008:* The project is completed and is in review status at UMESC (Upper Midwest Environmental Sciences Center – a division of USGS).

*For more information:*

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### **Bottomland Oak Underplanting and Natural Regeneration in a Private Forested Wetland**

*Project leader:* Jeff Esley (MDC)

*Collaborators:* David Gwaze and Dawn Henderson (MDC)

*Objectives:* The primary objective of this project was to assess the outcome of three differing oak regeneration treatments. This project was established to evaluate different site preparation methods in combination with different planting stock types to determine the relationship between biomass accumulation and light availability for four hard mast producing tree species.

*Summary of activities/findings in 2007:* The two site preparations included rotary brush shredder and complete plot clearing with a bull dozer. Four 2-acre clearings were divided into 3 subplots including natural regeneration, bare-root seedling, and container tree plantings. Tree species planted within the treatment plots included Pin oak, Swamp white oak, Bur oak, and Pecan. A total of 540 bare-root seedlings were planted along with 114 RPM (Root Production Method see [www.fknursery.com](http://www.fknursery.com)) container trees. Basal area was reduced to 50 sq ft/acre where necessary to ensure adequate light levels for planting stock types and natural



regeneration. In addition to site preparation, over story thinning, and tree planting, a cover crop was planted to reduce weedy and light seeded tree competition. The cover crop included a mix of Cuivre River Virginia Wildrye (15 lbs/acre) and Annual Cereal Rye (25 lbs/acre).

*Plans for 2008:* Biomass measurements will occur on an annual basis. Light availability (transmittance) will be tracked on a yearly basis to develop the relationship between site preparation, planting stock type, species, and biomass accumulation.

*For more information:*

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[Dawn.Henderson@mdc.mo.gov](mailto:Dawn.Henderson@mdc.mo.gov)

### **Survival and growth of planted oak seedlings in flooded environments from seed sources collected along a hydrological gradient**

*Project leader:* David Gwaze (MDC)

*Principal Investigator:* Mark Coggeshall (MU)

*Collaborators:* Jerry Vansembeek (USDA Forest Service), Mike Walsh (Student, MU)

*Objective:* 1) To determine differences in survival, recovery, and growth of oak seedlings from acorns collected along a hydrological gradient and subjected to controlled and flooded treatments. 2) To determine whether genetic variation to flood tolerance exists among open-pollinated families of swamp white, bur, and white oaks from seed sources located along a hydrological gradient (upland vs. bottomland sites).

*Summary of findings:* Nine seed sources of swamp white oak, eight seed sources of bur oak, and six seed sources of white oak were collected in the fall of 2005 from sites along a hydrological gradient of hydric to xeric. Sites were classified as upland or bottomland based on soil series information and probability of flooding events. Three-month old containerized seedlings were partially inundated in stock tanks under a 50% shade cloth. Flood treatments consisted of a 4-week flood, 8-week flood, and non-flooded control. Bur oak and swamp white oak seedlings from bottomland sources outperformed their upland counterparts in all three

treatments, while white oak seedlings from upland seed source outperformed the seedlings from bottomland seed sources. Overall survival grouped by hydrological position was greater for bottomland seed sources in both 4-week and 8-week flooded treatments. Family differences exist within species and hydrological position.

*Plans for 2008:* We will establish one or two field plantings on recently cultivated, flood-prone riparian sites within MDC Conservation Areas.

*For more information:*

[David.Gwaze@mdc.mo.gov](mailto:David.Gwaze@mdc.mo.gov)

Walsh, M. 2007. Variation in flood tolerance of three Midwestern oak species. M.S. Thesis, University of Missouri-Columbia. 97 p.

### **Oak underplanting in natural cottonwood stands**

*Project leader:* Lonnie Messbarger and Phil Sneed (MDC)

*Collaborators:* John Fleming, Craig Crisler, Dawn Henderson, Mike Wallendorf, and David Gwaze (MDC)



*Objectives:* The primary objective of this project was to develop fundamental information on the establishment and growth of bottomland hard mast producing species in over-stocked naturally regenerating cottonwood stands. Densely stocked cottonwood stands were thinned (30, 60, and 100% of the unthinned control) to serve as nurse trees for the hard mast species. Thinning the cottonwood is expected to improve the form of pecan, pin and bur oak planted in the stands as well as the production

of the cottonwood by reducing above- and below-ground competition.

*Summary of activities/findings in 2007:* The study was established at four sites. Four replications were established at Thurneau, Little Compton, and Nodaway Valley CAs. Three replications were established at Worthwine CA. Pecan, pin and bur oak were planted at 8 X 8 spacing in each of the replicates. Height of the hard mast species were recorded as well as height and dbh of the cottonwood. Light level readings in each of the replications were taken to help determine the relationship between biomass production of the desired species and thinning regime.

*Plans for 2008:* The planted hard mast trees will be assessed for survival, animal damage, and growth. Light levels and competition will also be assessed.

*For more information:*  
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### **Wetland Reserve Program RPM bare root study**

*Project leader:* Dawn Henderson (MDC)  
*Collaborators:* Rod Doolen (MDC), Kevin Dacey, (MDC/NRCS), Chris Hamilton and Doug Wallace (NRCS), Steve Sheriff (Biometrician, MDC)

*Objectives:* 1) Compare the relationship of growth and survival of bare root and RPM® planting stock to treatments (control, fertilization, herbicide, and combination of fertilization and herbicide). 2) Compare the species specific responses (survival, growth and masting) of pecan (*Carya illinoensis* (Wangenh.) K. Koch), pin (*Quercus palustris* Muenchh.), bur (*Quercus macrocarpa* Michx.), and swamp white (*Quercus bicolor* Willd.) oaks. 3) Determine the correlation of growth, survival and masting rates with soil type.



*Summary of activities/findings in 2007:* We have begun with soil sampling and analysis of the two planting sites in SE Missouri (Black Island and

Dark Cypress CAs). Tree planting for Dark Cypress will occur spring of 2008.

*Plans for 2008:* Once all trees have been planted initial biomass measurements (height, dbh, and/or root collar diameter) will be made. Application of herbicides will occur prior to bud break and during the growing season. Application of fertilizer will be during bud break or after any spring flooding has receded. Monitoring of vegetation in study plots will occur in spring and late summer.

*For more information:*  
[Dawn.Henderson@mdc.mo.gov](mailto:Dawn.Henderson@mdc.mo.gov)

### **Structural and Stand Diversity through mixed species plantings – Future project planning**

*Project leader:* Dawn Henderson (MDC)  
*Collaborators:* David Gwaze (MDC)

*Objectives:* Species such as sweetgum, river birch, green ash, sassafras, box elder, and red maple will be interplanted with pin oak to mimic structural and stand diversity seen in natural stand development. Using forest stand principles (crown architecture, crown abrasion, stand density, and phenology), the aim of this project is to increase survival and quality of desired species in afforestation efforts by increasing inter-specific competition and promoting canopy stratification.

*Plans for 2008:* Area managers will be asked to participate in 1 or 2 replications of 1 acre tree plantings. Managers will choose two “nurse” tree species that will be interplanted with pin oak at 2.4m (~8 X 8 ft) spacings. Biomass and light level readings will be collected on a yearly basis. Site selection will likely be limited to bottomland areas in the Mississippi and Missouri River floodplains or to their tributaries.

*For more information:*  
[Dawn.Henderson@mdc.mo.gov](mailto:Dawn.Henderson@mdc.mo.gov)

# Upland Oak Natural Communities

## Restoration and Maintenance of Upland Oak Communities on Mesic Sites

*Project Leader:* Carrie Steen (RSD)

*Collaborators:* Mike Wallendorf, Greg Gremaud, John Fleming, George Clark, Josh Stevens, David Vance, Mike Flaspohler, Yvette Amerman, Lonnie



Messbarger, Phil Sneed, Gus Raeker, and Rick Johnson (MDC), John Kabrick and Dan Dey (USDA Forest Service)

### *Objectives:*

To determine the effects of different levels of light intensity on survival, growth and age/size class advancement, and effects of prescribed burning combined with competition removal on achieving adequate oak advanced reproduction.

*Summary of activities/findings in 2007:* We completed plot establishment and data collection for dormant and growing season vegetation, light measurements and canopy cover for the St. Louis region (Daniel Boone, Little Lost Creek, Reifsneider CAs) and Elmslie CA in the Northeast. Treatments began in late summer 2007. Initial data from these sites shows clearly a higher stem density of oak than maple in the regeneration class (< 3.3 ft height), but a midstory where maple stem density is greater than oak.

*Plans for 2008:* Plots will be established and pre-treatment dormant/growing season collected for the Northwest region (Poosey, Bluffwoods, Riverbreaks CAs) and one more site in the Northeast (Sugar

Creek). We hope to get the third Northeast site in progress as well. Summer of 2008, we will also begin first post-treatment data collection for the St. Louis region.

*For more information:*

[Carrie.Steen@mdc.mo.gov](mailto:Carrie.Steen@mdc.mo.gov)

## Site Quality Effects on Growth Rate of Competitive Maple and Oak in Clearcuts

*Project Leader* – Carrie Steen (MDC)

*Collaborators* - Josh Stevens (MDC), David Larsen (MU), John Kabrick (USDA Forest Service), Rose-Marie Muzika and Randy Miles (MU), Gus Raeker and Aaron Holsapple (MDC), Dennis Meinert (DNR).

*Objectives:* To determine growth rates of *Quercus* spp. and *Acer saccharum* when in direct competition and identify specific site qualities that effect growth rate changes so that land managers may efficiently provide sustainable upland oak communities.

*Summary of activities/findings in 2007:* This is a Regional Management Evaluation project that is being used concurrently for a graduate thesis (J. Stevens). Activities in 2007 included budget proposal review and preliminary data collection to review methods.

*Plans for 2008:* Data collection will be conducted and initial analyses will begin.

*For more information:*

[Josh.Stevens@mdc.mo.gov](mailto:Josh.Stevens@mdc.mo.gov)



## Annual mast survey

*Project Leader:* David Gwaze

*Collaborators:* MDC Forestry Division staff

*Objective:* The oak mast survey is conducted annually by Forestry Division staff to provide an index to the availability of oak mast, giving us an indication of what is in store for mast-dependent forest wildlife during fall and winter. Poor mast years have been shown to result in lowered reproductive success and reduced numbers of mast-dependent forest wildlife.



*Summary for 2007:* A total of 3,847 oak trees were sampled: 2047 from the red oak group and 1800 from the white oak group. Combining the two oak groups, mast production was poor with decline of 49% from the 48-year average and 81% from last year's mast production. This year's mast production was the 4<sup>th</sup> lowest index recorded since 1960 (Fig 3). The white oak production (index of 26) was the lowest recorded since 1960. It was a decline of 388% from the 48-year long-term average and 535% from last year's mast production. Red oak index (145) was good and well above the red oak long-term average (138). Compared to last year, the red oak index was slightly lower (8%).

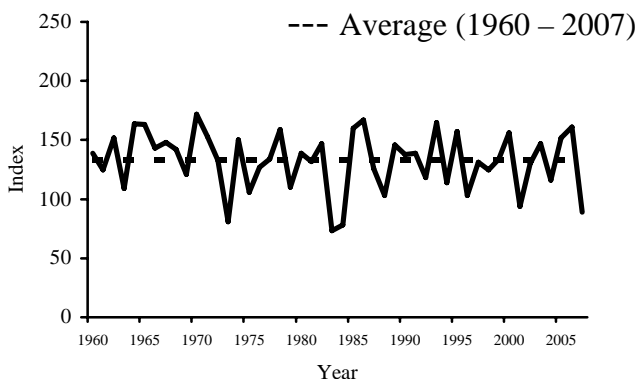


Figure 3. Statewide mast index for all oaks, 1960-2007.

We attribute the decline in white oak mast production to the late-spring freeze. In white oaks, production of acorns takes place in the same season in which the flowers are fertilized. The late-spring freeze damaged the flowers and, thus, reduced

white oak mast production. On the other hand, mast production in red oaks was good because acorn production takes place over two growing seasons. Red oaks fertilized in 2006 produced the 2007 mast crop, escaping the freeze. We expect the 2008 red oak acorn crop to decline significantly because most of the 2007 flowers were damaged by the freeze.

The need to maintain mixed stands of red oaks and white oaks in order to avoid complete mast failures cannot be over emphasized. The 2007 mast survey results clearly indicate that if stands were composed of only white oaks, a complete mast failure would have occurred.

*For more information:*

[David.Gwaze@mdc.mo.gov](mailto:David.Gwaze@mdc.mo.gov)

## Hard Mast Species Light Level Needs – Preliminary information gathering project

*Project leader:* Dawn Henderson (MDC)

*Collaborators:* Mike Anderson, Ross Glenn (MDC)

*Objectives:* To determine the correlation between light levels in the forest understory to growth of hard mast producing species. We hope to determine the light level that allows for growth while keeping competition at a minimum.

*Summary of activities/findings for 2007:* We are currently working in two areas (Swift Ditch and 76 CAs). A midstory thinning (hack and squirt) was applied to three areas at 76 in 2006. At 76 CA growth measurements and light levels were recorded for the past two years. T-tests show significant differences for growth between the control and thinned areas. An underplanting occurred at Swift Ditch in late 2006. Initial biomass measurements and light levels were recorded this year.

*Plans for 2008:* We will continue to monitor the growth and light levels at both locations. Once next year's growth and light levels have been recorded, a model will be developed to determine the correlation between the two parameters.

*For more information:*

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# Missouri Ozark Forest Ecosystem Project (MOFEP)

**MOFEP Overview:** This project began in the late 1980's from discussions concerning the impact of clearcuts on neotropical migrant, forest interior birds. The idea expanded to become a long-term evaluation (100+ years) of multiple ecosystem facets. It is designed as an experiment with 3 treatments: even-aged management, uneven-aged management and no harvest. Pre-treatment data were collected starting five years before the initial harvest entry in 1996. The next harvest entry is scheduled for 2011. For more information, see the MOFEP website: <http://mofep.mdc.mo.gov/>

## MOFEP Hardmast Study

*Project Leader:* Carrie Steen (MDC)  
*Collaborators:* Steve Sheriff, Randy Jensen, and Larry Vangilder (MDC)

*Objectives:* Sustainable regeneration of oak-hickory forests and production of key wildlife forage through hardmast production.

*Summary of activities/findings in 2007:* This study was successfully reviewed and approved for continuation in 2006. Data collection and processing has continued and we are working on data quality for existing data. We are also getting new GPS coordinates with greater accuracy for use in any future spatial analyses.

*Plans for 2008:* Data collection will continue and we hope to begin updating overstory data in the hardmast plots.

*For more information:*  
[Carrie.Steen@mdc.mo.gov](mailto:Carrie.Steen@mdc.mo.gov)



## MOFEP- The Effects of Forest Management on Songbirds

*Project leader:* Andy Forbes (MDC)  
*Collaborators:* Paul Porneluzi (Central Methodist University), John Faaborg (MU), Mike Wallendorf (MDC)

*Objectives:* To evaluate effects of even-aged (EAM), uneven-aged (UAM), and no-harvest (NH) management on populations of forest interior and early-successional breeding bird species.

*Summary of activities/findings in 2007:* We continued to map territories, monitor nests, and band birds on a subsample of monitoring plots. All forest interior species declined immediately following treatments in 1996, however, two species (Wood Thrush and Kentucky Warbler) showed a positive association with forest immediately adjacent to cuts. Ovenbirds showed a negative association with cuts, and also declined overall throughout EAM stands. Early-successional species (Indigo Bunting, Yellow-breasted Chat, Prairie Warbler, and White-eyed Vireo) showed a positive response to both EAM and UAM habitat treatments. Brown-headed Cowbird parasitism rates and nest predation rates continue to be low overall, and did not increase following treatments.

*Plans for 2008:* Full-scale monitoring will take place on plots throughout all nine MOFEP study areas in 2008 continuing each year until harvest in 2011.



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*For more information:*

[Andrew.Forbes@mdc.mo.gov](mailto:Andrew.Forbes@mdc.mo.gov)

Clawson, Richard L. and Paul A. Porneluzi. 2007. The Effects of Forest Management on Songbirds in the Missouri Ozark Forest Ecosystem. Science Notes, MDC Resource Science Division, Vol. 2 (10).

Wallendorf, M. J., Porneluzi, P. A., Gram, W. K., Clawson, R.L. and J. Faaborg. 2007. Bird Response to Clear Cutting in Missouri Ozark Forests. Journal of Wildlife Management 71: 1899-1905.

## MOFEP Ground flora/ soft mast study

*Project leader:* Susan Farrington (MDC)

*Collaborators:* Randy Jensen (MDC), Jenny Grabner, Debby Fantz and Mike Wallendorf (MDC)

*Objectives:* To sustainably regenerate oak-hickory forest and woodland while maintaining or restoring native ground flora natural communities and



encouraging production of key wildlife forage through soft mast production.

*Summary of activities/findings in 2007:* We monitored vegetation and soft mast in a sub-sample of vegetation plots in 2007. We are currently analyzing the data collected, as well as the data collected from 1993-2002. Preliminary findings from 1993-2000 ground flora data included a significant loss in species richness in no harvest (control) sites. We will be examining species losses and increases to determine if natural community composition is shifting and to determine the conservative value of the plants that we are gaining or losing.

*Plans for 2008:* Report on data analysis efforts, and prepare for full-scale monitoring to be conducted in 2009 and 2010.

*For more information:*

[Susan.Farrington@mdc.mo.gov](mailto:Susan.Farrington@mdc.mo.gov)

## MOFEP Amphibian, Reptile, and Small Mammal Study

*Project Leader:* Rochelle Renken

*Collaborators:* Steve Sheriff (MDC) and Joshua Millsaugh (MU)

*Objectives:* Evaluate the response of amphibian, reptile, and small mammal communities to even-aged, uneven-aged, and no-harvest forest management in Missouri's Ozark forests. In addition, evaluate the potential impact of current research methodology on amphibian and reptile communities within MOFEP study sites.

*Summary of activities/findings in 2007:* We are preparing to reinitiate amphibian and reptile sampling in the spring of 2008. Amphibian and reptile communities will be sampled during March through June, and September through October in 2008, 2009, and 2010. Small mammal communities will be sampled in April and May of 2008, 2009, and 2010. From information we collected during 1992 through 2000, we learned that on a landscape-scale, amphibian and reptile communities were not impacted by the changed forest conditions following the 1996 harvest, but that amphibian and reptile capture rates appeared to be most impacted by a region-wide drought. Amphibian capture rates declined following the 1996 harvest, but declined



Jim Rahtert

on no-harvest sites as well as on even-aged and uneven-aged sites. Even-aged forest management appeared to dampen a natural decline in small mammal capture rates that was observed on no-harvest and uneven-aged study sites. The region-wide drought likely caused a natural decline in small mammal numbers in most areas, but we suspect the increased cover and food resulting from even-aged management blunted the drought impacts on small mammal communities on even-aged management sites. No species of amphibians, reptiles, and small mammals appeared or disappeared on the study sites because of the 1996 tree harvest.



*Plans for 2008:* Trapping for amphibians, reptiles, and small mammals will be done in 2008, 2009, and 2010. The second entry harvest on MOFEP sites will occur in 2011. Information gathered in 2008, 2009, and 2010 will be compared with information gathered in 1992 through 2001 to learn how animal communities have fared since the 1996 first-entry harvest.

*For more information:*

[Rochelle.Renken@mdc.mo.gov](mailto:Rochelle.Renken@mdc.mo.gov)

Renken, R. B., W. K. Gram, D. K. Fantz, S. C. Richter, T. J. Miller, K. B. Rieke, B. Russell, and X. Wang. 2004. Effects of forest management on amphibians and reptiles in Missouri Ozark forests. *Conservation Biology* 18:174-188.

Fantz, D.K. and R.B. Renken. 2005. Short-term landscape-scale effects of forest management on *Peromyscus* spp. mice within Missouri Ozark forests. *Wildlife Society Bulletin* 33:293-301.

### **MOFEP: Influence of Forest Management on Insect Herbivore Abundance on Oaks**

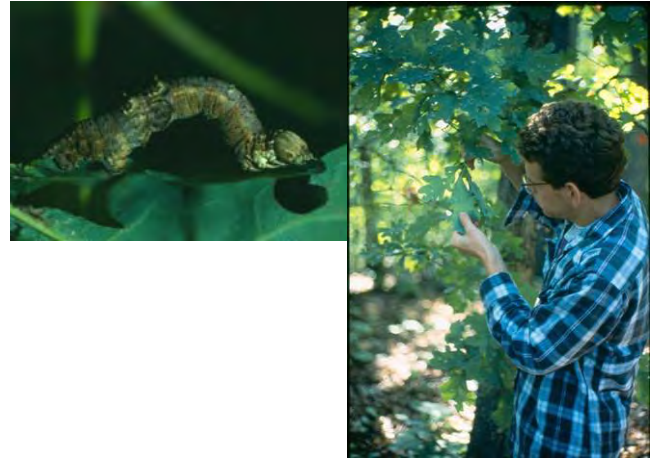
*Project Leaders:* Randy Jensen, Robert Lawrence (MDC)

*Principal Investigator:* Robert Marquis (UMSL)

*Team members and affiliation:* John Landosky (UMSL), Carrie Steen and Rochelle Renken (MDC), Paul Porneluzi (Central Methodist University), John Faaborg (MU)

*Objectives:* The main objective of our study is to quantify changes in abundance, diversity and community structure of the oak-feeding insects over time as affected by MOFEP treatments. In so doing, we can determine which forest management plan will be least likely to result in damaging insect outbreaks.

*Summary of activities/findings in 2007:* We have monitored insect abundance on white and black oak on ELTS 11 (canopy), 17 and 18 (understory) continuously since 1993. Insect abundance is reduced in clearcuts compared to neighboring understory on black oak, and species richness is changed (lower for white oak and higher for black oak) at the landscape level in uneven aged management compared to even aged management and no harvest. Late spring frosts significantly reduce insect numbers.



*Plans for 2008:* We plan to continue sampling through 2012, and add components of measuring leaf damage and leaf quality as affected by treatments. Further, we are integrating data from bird and hardmast studies to determine the extent of spatial and temporal correlations with insect abundance.

*For more information:*

[Randy.Jensen@mdc.mo.gov](mailto:Randy.Jensen@mdc.mo.gov)

### **MOFEP: Carbon Flux and Storage in Mixed Oak Forests of MOFEP**

*Project leader:* Randy Jensen (MDC)

*Principal Investigator:* Jiquan Chen, University of Toledo, OH.

*Collaborators:* John Kabrick (USDA Forest Service)

*Objectives:* (1) To continue field measurements of various carbon (C) fluxes/stocks and associated soil and vegetation measurements (e.g., microclimate) to understand the intra-annual variability (i.e., climate controls) following the alternative treatments. (2) To evaluate detailed biogeochemical regulations of the C cycle, including water use, light use, nutrient use efficiencies. (3) To model and predict the changes in C credits of different silvicultural options and of the landscape (i.e., remote sensing and ecosystem modeling).

*Summary of activities/findings in 2007:* Quantified carbon pools of MOFEP experiment plots in a publication on *Canadian Journal of Forest Research*. Completed one Ph.D. dissertation

(Qinglin Li) and one M.S. thesis (Rachel Henderson). Submitted two additional manuscripts for journal publications. Continued field measurements of soil respiration, microclimate, and decomposition. Submitted a large scale proposal to the National Science Foundation to expand our current research to include resource use efficiencies in a changing climate.

*Plans for 2008:* We plan to synthesize our field measurements of soil carbon efflux to address the intraannual variations of soil carbon efflux. We will analyze the change of carbon pools and fluxes of alternative silvicultural treatments on carbon credits and stock at MOFEP sites using the long term overstory plots. If NSF proposal is funded, we will begin our field installations of towers (3) and sensors next fall, including sapflows, carbon and N sensors, rain bags, etc.

*For more information:*  
[Randy.Jensen@mdc.mo.gov](mailto:Randy.Jensen@mdc.mo.gov)

*Project webpage (will be updated in Spring 2008):*  
<http://research.eescience.utoledo.edu/lees/research/MOFEP/>  
Chen, J., Paul Alaback, Mark Harmon, et al. Evolution of Forest Management: Past, Current and Future. *Journal of Integrative Plant Biology* (invited manuscript due end of April)  
Li, Q., D. L. Moorhead, J. L. DeForest, and J. Chen, R. Henderson, R. Jensen. Mixed litter decomposition in a managed Missouri Ozark forest ecosystem. *Forest Ecology and Management* (submitted).  
Li, L. J. Chen, J. L. DeForest, R. Jensen, D. L. Moorhead, and R. Henderson. 2007. Effects of timber harvest on carbon pools in Ozark forests. *Canadian Journal of Forest Research* 37: 2337-2348.  
Li, Qinglin . 2006. Carbon storage and fluxes in a managed oak forest landscape. Ph.D. Thesis, University of Toledo, Currently Ecologist, Timberline Natural Resources Ltd., Canada  
Henderson, Rachel. 2007. Soil Effluxes of vertical profiles at MOFEP Experiments. M.S. Thesis, University of Toledo. Currently a research assistant at the Rocky Mountain Ecology Lab.

## **MOFEP: Effects of Forestry Practice on Human Risk of Exposure to Tick-Borne Diseases**

*Project Leader:* Brian F. Allan, Washington Univ.

*Collaborators:*  
Jonathan M. Chase,  
(Washington Univ.),  
Richard S. Ostfeld,  
(Institute of  
Ecosystem Studies),  
Lisa Goessling and  
Robert Thach  
(Washington Univ.)



Jim Rahtert

*Objectives:* To determine if different timber management practices influence the human risk of infection by tick-borne pathogens through changes in the abundance of ticks and/or their vertebrate hosts. Multiple species in the bacterial genera *Ehrlichia* and *Borrelia* occur in Missouri, and several of these cause disease in humans, their pets, and wildlife. One common species is *Ehrlichia chaffeensis*, which causes Human Monocytic Ehrlichiosis (HME), an emergent zoonotic disease in North America. The area of highest incidence of HME occurs in southeastern Missouri, making MOFEP an ideal location to study the ecology of this pathogenic organism.

*Summary of activities:* Differences in tick abundance among the MOFEP forestry treatments were estimated using two survey techniques: drag-sampling and CO<sub>2</sub> baited traps. Deer abundance was estimated by performing dung cluster surveys. Small mammal activity was assessed by the use of track plates. Abiotic variation in tick habitat suitability among habitats was measured using remote data loggers and through tick survival experiments.

*Plans for 2008:* Collection of field data is mostly finished. Laboratory analyses are being conducted currently to determine tick infection rates with pathogens and to identify the sources of host blood meals using several novel molecular tools.

*For more information:*  
Contact Brian Allan ([ballan@wustl.edu](mailto:ballan@wustl.edu))

## MOFEP: Changes in Soil Nutrient Cycling and Availability Due to Different Forest Management Methods

*Project Leader:* David Gwaze (MDC)

*Principal Investigator:* Keith Goyne (MU)

*Collaborators:* John Kabrick (USDA Forest Service), Peter Motavalli (MU), Mike Wallendorf (MDC)

*Objectives:* The primary objectives of this study are to examine how landscape factors influence nutrient status in MOFEP soils and to quantify the effects of different harvest management practices on nutrient cycling (the continual movement of nutrients between soil, plants, animals and the atmosphere) and availability in soils with differing nutrient supplying capacities.

*Summary of activities/findings:* We initiated a study in 2007 to investigate forest management (even-aged, uneven-aged and no harvest) effects on nutrient cycles and nutrient pools in soils at MOFEP. We are presently examining site factors including the underlying geologic formation, soil parent material, landform and slope position, slope-aspect, depth to bedrock, drainage class, forest type, and ground flora indicator species. Approximately 20% of the dataset has been completed to date and we anticipate that it will be finished in May 2008. Once completed, we will proceed with Classification and Regression Tree Analysis (CART) to identify and rank important explanatory site factors related to base cation supply.

At each of the three soil types (high, moderate and low nutrient status) within a block, samples (1 kg per depth) were collected from hand-dug pits that were sampled in 10 cm increments from 0-30 cm. For each soil type, three pits were located within a clearcut or surrounding a stump and three were located in paired non-harvested areas. This paired sampling approach was also used at no harvest management sites for consistency purposes despite the fact that harvested areas are non-existent. A total of 486 soil samples were collected.

After air-drying, 250 soil samples were ground and sieved to 2 mm and sent to the Missouri Soil Characterization Lab (SCL) for physical and chemical analyses. Soil texture, cation exchange

capacity and exchangeable cations, pH, exchangeable acidity, and organic carbon content are being quantified for each sample. The SCL data will be used to determine any differences in pH and base cation contents in soils across map units and harvest treatments.



Experiments have been initiated to determine relative potentially mineralizable N using an aerobic incubation and leaching procedure. In brief, soils stored at field moist conditions at 4°C are incubated at 30°C in filter units. The filter units are leached on days 0, 1, 3, 7, 14, 21, 28, 42, 56, 70, and 84 with an N-free nutrient solution and leachates are analyzed for  $\text{NH}_4^+$  and  $\text{NO}_3^-$ . Samples are incubated in groups of 100 samples for purposes of practicality, and the estimated completion time for incubation experiments is April 2009.

### *Plans for 2008:*

Additional samples will be sent to SCL for analysis and cool storage samples will be analyzed to determine total N, labile and stable N and soluble N. Additional phases of the project will also be initiated.





# Fire Ecology

## Assessing the effects of fire on common prickly-ash (*Zanthoxylum americanum*) and multiflora rose (*Rosa multiflora*) in the understory

*Project Leader:* Darlene Hoffman (MDC)

*Cooperators:* Tony Elliott, Jason Jacobson, and Greg Gremaud (MDC)

*Objectives:* To determine if prescribed fire during 4 to 5 consecutive spring seasons can achieve the desired levels of control for both common prickly-ash and multiflora rose, we are conducting a management evaluation at Charlie Heath Memorial CA. Monitoring objectives include tracking the response of common prickly-ash and multiflora rose to repeated prescribed fire in order to document when the desired levels of control are reached or, if necessary, to suggest changes in the future fire regime. A second monitoring objective is to qualitatively document oak sprouting and forest-floor flora response to the prescribed fire regime.

*Summary of activities/findings in 2007:* We conducted the third annual burn in unit 1 and the second annual burn in unit 2 during April, 2007. We also conducted stem counts of prickly-ash and multiflora rose within our plots (prior to the burns) and completed a floristic survey of the units during the summer. After the first burn, there was extensive resprouting by both species, but resprouting appears much reduced in unit 1 after the second burn. Forest ground flora species richness and abundance has not changed significantly.



*Plans for the 2008:* We will conduct stem counts this winter, burn both units during the spring, and conduct the floristic survey during the summer. If re-sprouting in unit 1 is still infrequent, we will consider reducing the fire frequency to every other or every third year.

*For more information:*

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## Effects of Prescribed Fire in Upland Forests and Woodlands

*Project leader:* Aaron Stevenson (MDC)

*Collaborators:* Gary Gognat (MDC), Steve Paes (MDC), Susan Farrington (MDC), Randall Roy (MDC), Dan Drees (MDC), Richard Guyette (MU), Mike Stambaugh (MU), Alexander Wait (MSU)



*Objectives:* To study the effects of prescribed burning on forest and woodland communities

*Summary of activities/findings in 2007:* We monitored vegetation and fire scarring at Rocky Creek CA, Fourche Creek CA, and Caney Mountain CA this past summer (2007). Current efforts focus on analyzing data collected from 2005-2007 at Rocky Creek CA and Fourche Creek CA. A preliminary report for Rocky Creek CA woodland restoration sites indicates an increase in species richness and woodland indicator plants for most treatments. Photographs from Fourche Creek CA show an amazing herbaceous response after one prescribed fire. Future research will continue to focus on vegetation monitoring while incorporating assessment of timber volume losses due to fire scars.

*Plans for 2008:* Inventory cavity trees across woodland restoration sites and assess timber damage from fire scars.

*For more information:*

[Aaron.Stevenson@mdc.mo.gov](mailto:Aaron.Stevenson@mdc.mo.gov)

Stevenson, Aaron P. Effects of prescribed burning in Missouri Ozark upland forests. University of Missouri, Columbia, MO. MS Thesis.

<http://edt.missouri.edu/Fall2007/Thesis/StevensonA-112807-T8770/research.pdf>

# Water Quality

## Evaluating timber harvesting effects on water quality in low-order streams

*Project leader:* David Gwaze (MDC)

*Principal Investigator:* John Bowders (MU)

*Collaborators:* Steve Burm and Terry Thompson (MDC), Keith Moser (USDA Forest Service), Amod Koirala and James Bryce (Students, MU).

*Objectives:* To test the efficacy of MDC's current BMPs during timber harvesting and to provide an understanding of the processes in ephemeral streams adjacent to harvested areas. Positive results (i.e. water quality not impacted) will demonstrate that the current best management practices are effective and that MDC should continue to use them. Negative findings (i.e. water quality impacted) will give MDC an opportunity to revise their BMPs in order to protect water quality during timber operations.



*Summary:*

Research sites were selected

in the Missouri Ozarks at the Current River and Angeline Conservation Areas. Major tasks undertaken during the year include: maintaining and updating over 170 pieces of instrumentation; complete characterization of landscape attributes; and conducting five water sampling events of all fifteen sites which are located in the Current River and Angeline Conservation Areas. Water samples have been collected from in-stream or hillslope samplers and analyzed for: pH, electrical conductivity, total suspended solids, total volatile solids, total nitrogen, nitrate (NO<sub>3</sub>), and ammonia (NH<sub>4</sub>), phosphorous, soluble reactive phosphorous, calcium, magnesium, and potassium.

*Plans for 2008:* Continued routine water/sediment sampling and analytical analyses, continued performance monitoring and maintenance of on-site equipment. A proposal will be developed to look at impacts of logging roads on water quality.

*For more information:*

[David.Gwaze@mdc.mo.gov](mailto:David.Gwaze@mdc.mo.gov)

# Nursery Production

## Influence of Seedling Storage on Performance of Planted White Pine

*Project leader:* Greg Hoss (MDC)

*Collaborators:* David Gwaze, Kristen Goodrich (MDC), Mark Coggeshall (MU)

*Objective:* To determine effects of length of seedling cold storage on survival and growth of planted white pine seedlings.

*Summary:* Over the past few years there have been numerous reports from private landowners of poor survival of white pine seedlings purchased from the George O. White State Nursery. The cause was not obvious because the seedlings appeared healthy when they were packed and shipped from the Nursery. An experiment was established to determine effects of seedling storage on survival and growth of seedlings. The cold storage treatments evaluated were: 1 day, 8 days, 23 days and 44 days. At two months after planting, seedlings stored for 23 days had the poorest survival, and the other treatments had survival greater than 70%. Six months after planting, survival in all treatments dropped to less than 50%, probably due to summer drought. Six months after planting, survival of seedlings stored for one day was higher than those stored for longer durations. Height growth increments were not significantly different among treatments, indicating that growth was not influenced by storage. The study results show that field survival is directly influenced by length of time seedlings are stored in cold storage. Lengthy storage of white pine should be avoided. Lifting immediately before planting will improve survival, but will not affect height growth.

*For more information:*

[David.Gwaze@mdc.mo.gov](mailto:David.Gwaze@mdc.mo.gov)

Gwaze, D. and Hoss, G. 2007. Influence of seedling storage on performance of planted white pine. Missouri Department of Conservation Science Notes Volume 2 no. 13. 2p

# Forest Health

## Missouri Forest Health Program Overview

*Project leaders:* Rob Lawrence, Bruce Moltzan (MDC)

*Collaborators:* Dennis Haugen, Manfred Mielke, Mike Connor (USDA Forest Service)

### *Objectives:*

To conserve Missouri's forest resources by monitoring and evaluating forest health and providing forest health management information to the people of Missouri.

### *Summary of activities/findings in 2007:*

Responded to major forest damage events with field evaluations and outreach efforts. A feature article on frost damage was displayed on the MDC web site following severe frost events in April. Field evaluations were done on outbreaks of aphids on walnut and other hardwoods and Ips bark beetles on shortleaf pine. Pest alert handouts for these outbreaks were produced and distributed by email, at workshops, and State Fair. Investigated the first trees in Missouri known to be infested and killed by a new invasive pest, the banded elm bark beetle (found in Dutch-elm-disease resistant elms in Forest Park in St. Louis).

A variety of other outreach efforts occurred throughout the year. Diagnostic results and management recommendations were given out through approximately 1300 contacts (phone calls, e-mails, letters, laboratory reports, and site visits). A total of 240 samples were received and diagnosed in the Forest Health Diagnostic Clinic. Four issues of the Missouri Forest Health Update newsletter were produced and distributed to MDC staff, arborists, forestry consultants, and university and government cooperators. Forest pest management seminars were presented to commercial arborists, community foresters, Christmas tree growers, Missouri Pesticide Applicator Training Program, and others. Additional information was distributed through newspaper articles, media interviews and media releases.

*Plans for 2008:* Monitoring, evaluation and outreach efforts will continue as in past years. The

Forest Health Update series will begin distribution again in Spring. Development continues on tri-fold pamphlets of major forest diseases.

*For more information:*

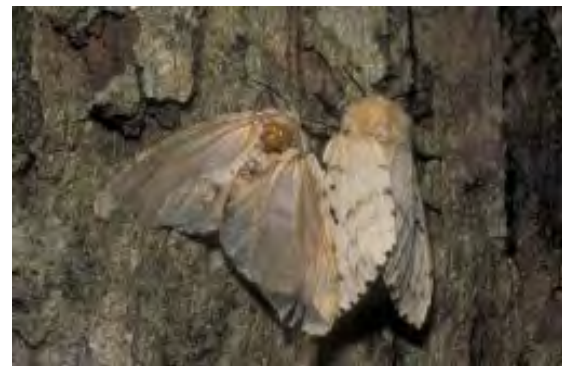
[Robert.Lawrence@mdc.mo.gov](mailto:Robert.Lawrence@mdc.mo.gov)

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## Missouri Cooperative Gypsy Moth Survey

*Project leader:* Rob Lawrence (MDC leader)

*Collaborators:* Rob Emmett, Nate Forbes, Joe Garvey, Tom Draper, Lonnie Messbarger and others (MDC), Collin Wamsley & Jimmy Williams (MO Dept. Agriculture, Statewide project leaders), Mike Brown & Brian Deschu (USDA-APHIS-PPQ), Dennis Haugen (USDA Forest Service), and other members of the Missouri Gypsy Moth Advisory Council.



### *Objectives:*

To detect the presence of populations of the gypsy moth, a highly damaging invasive forest pest that is expanding its range toward Missouri from the northeastern U.S.

### *Summary of activities/findings in 2007:*

The annual cooperative gypsy moth survey is led by the Missouri Dept. of Agriculture. Over 9,900 pheromone traps were placed and monitored statewide by 6 state and federal agencies during May to August. A total of seven gypsy moths were captured with four in St. Louis County and one each in Jackson, Greene, and Stone Counties. These captures are likely the result of gypsy moth life stages hitchhiking on interstate movement of goods and vehicles. No gypsy moth populations are known to be established in Missouri.

MDC's role in the survey consisted in part of placing and monitoring 5,100 traps in 27 counties in



St. Louis, Ozark, Southeast and Northwest Regions. Supervision and support of survey crews was provided by numerous people in Forestry Division. MDC also provided all necessary GIS and data management services statewide to the six cooperating agencies.

*Plans for 2008:*

The annual survey will be continued in a similar manner statewide in 2008. Locations where gypsy moths were captured in 2007 will be surveyed at a greater trapping density to detect possible established populations.

*For more information:*

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<http://www.mdc.mo.gov/forest/health/gypsy>

### **Missouri Emerald Ash Borer Project**

*Project leader:* Rob Lawrence (MDC)

*Collaborators:* Brian Canaday, Justine Gartner, Matt Seek (MDC), Anastasia Becker, Collin Wamsley (MO Dept. Agriculture), Mike Currier (MDNR) Mike Brown (USDA-APHIS-PPQ), Dennis Haugen, Steve Katovich (USDA Forest Service).

*Objectives:* To reduce the risk of infestation, increase readiness to respond to infestations, and detect the presence in Missouri of the emerald ash borer (EAB), an invasive forest pest that threatens to eliminate ash (*Fraxinus* spp.) from North America.

*Summary of activities/findings in 2007:*

A multi-agency Emerald Ash Borer Technical Team drafted the Missouri EAB Action Plan, which was sent to stakeholders for review. Work continues now on the final plan.

The annual EAB survey was conducted during July and August with crews from MDC, MO Dept. Agriculture, US Forest Service, and Missouri Master Naturalists visiting high-risk sites (campgrounds, urban developments with ash plantings) around the state. Declining ash trees at 294 sites were examined for evidence of EAB. None was found. No established populations of EAB have yet been found in Missouri.



David Cappaert  
[www.forestryimages.org](http://www.forestryimages.org)

J W Smith, USDA-APHIS-PPQ-PERAL

Several outreach efforts were undertaken to raise awareness about EAB and movement of firewood as a major pathway for introduction of this insect. An article, "Hitchhiking Bugs", was published in the "Missouri Conservationist". Reprints of the article have been distributed at the State Fair, MDC offices, and numerous workshops for the green industry. The following handouts were developed and distributed by email and workshops: "EAB Frequently Asked Questions", "EAB and Look-Alike Insects", and "Is It EAB, Ash Decline, or Something Else?" Presentations were made at the Missouri Natural Resources Conference and several workshops for arborists and landowners. Information was further dispersed through media interviews and media releases.

*Plans for 2008:*

The EAB Action Plan is scheduled to be completed in 2008, and more emphasis will be placed on involving more stakeholders in planning efforts. Visual surveys will again be conducted by MDC, MDA and others. USDA-APHIS will place and monitor several experimental traps for detecting EAB. A variety of outreach efforts will continue.

*For more information:*

[Robert.Lawrence@mdc.mo.gov](mailto:Robert.Lawrence@mdc.mo.gov)

<http://www.mdc.mo.gov/forest/features/firewood.htm>

## Oak Wilt Vector Study

*Project leader:* Bruce Moltzan (MDC)  
*Collaborators:* Maya Hayslett (Univ. of Wisconsin), Jennifer Juzwik (USDA Forest Service).

*Objectives:* To develop baseline knowledge on vectors transmitting oak wilt in central hardwood oak ecosystems and to delineate timing of transmission.

*Summary of activities/findings in 2007:*  
Red oak trees were wounded in 2005 and again in 2006. Fresh wounds attract insects and the timing of their activity is believed to be linked to oak wilt fungal mat production.  
Three species of *Colopterus*: *C. truncatus*, *C. niger*, and *C. semitectus* were identified as vectors with their greatest activity occurring in April and lowest transmission potential occurring by June.

No ongoing work is scheduled on this project for 2008.

*For more information:*  
[Bruce.Moltzan@mdc.mo.gov](mailto:Bruce.Moltzan@mdc.mo.gov)

Hayslett, M., Juzwik, J., and Moltzan, B. 2008. Three *Colopterus* beetle species carry the oak wilt fungus to fresh wounds on red oak in Missouri. *Plant Dis.* 92:270-275.

## Phytophthora Study

*Project leader:* Bruce Moltzan (MDC)  
*Collaborators:* B. W. Schwingle (USDA Forest Service), Jennifer Juzwik (USDA Forest Service), J. Eggers (West Virginia University).

*Objectives:* Detection of naturally occurring *Phytophthora* species in decline-affected and non-affected oak forests in Missouri.

*Summary of activities/findings in 2007:*  
To our knowledge, this is the first report of *Phytophthora* species in soils of Missouri oak forests, of *P. quercina* in the United States, and of the ability of *P. cambivora* to cause stem lesions on *Q. alba*. *P. cinnamomi* and *P. cambivora* should be investigated *in situ* as possible contributing factors of oak decline in Missouri.

Project completed 2007.

*For more information:*  
[Bruce.Moltzan@mdc.mo.gov](mailto:Bruce.Moltzan@mdc.mo.gov)

B. W. Schwingle, B.W., Juzwik, J., Eggers, J., and Moltzan, B. 2007. *Phytophthora* Species in Soils Associated with Declining and Non-declining Oaks in Missouri. *Plant Dis.* Vol. 91:5, p.633

## Banded Elm Bark Beetle Study

*Project leader:* Bruce Moltzan (MDC)  
*Collaborators:* Jana Lee (UC Davis), Steve Seybold (USDA Forest Service).

*Objectives:* Survey for an exotic elm bark beetle.



Whitney Cranshaw [www.forestryimages.org](http://www.forestryimages.org)

*Summary of activities/findings in 2007:*  
Survey for the invasive banded elm bark beetle (*Scolytus schevyrewi*) was conducted over four MDC areas in 2007 using three trapping techniques. This survey was part of a project to study the distribution and abundance of *S. schevyrewi* found in North America after the beetle's introduction from Asia.

No ongoing work is scheduled for 2008.

*For more information:*  
[Bruce.Moltzan@mdc.mo.gov](mailto:Bruce.Moltzan@mdc.mo.gov)  
Jana C. Lee, Ingrid Aguayo, Ray Aslin, Gail Durham, Shakeeb Hamud, Bruce Moltzan, A. Steve Munson, Jose F. Negron, Travis Peterson, Iral Ragenovich, Jeff J. Witcosky, Steven J. Seybold. Trend of two invasives: Banded and European elm bark beetle. California Forest Pest Council Workshop, Woodland, CA. Nov 2007. ESA National Meeting, San Diego, CA. Dec 2007.  
[http://janalee.net/z\\_pdf/cfpc07-schevy1.pdf](http://janalee.net/z_pdf/cfpc07-schevy1.pdf)

# Forest Economics

## Forest Inventory and Analysis (FIA National Grid)

*Project leader:* Tom Treiman (MDC), Keith Moser (USDA Forest Service)

*Objectives:* As part of the USDA Forest Service national program to monitor forest acreage, biomass, volume, growth, removals and mortality, a grid of 1 plot per approximately 6,000 acres was established in Missouri. Each plot is visited once every 5 years (by Forest Service foresters), and a suite of plot, tree, forest health and other measures are taken on each plot.

*Summary of activities/findings this year:* Each year, MDC and the Forest Service produce an updated report of the past 5 years' (complete cycle) finding. Every 5 years a more major report is produced. Data is also available on the web. Reports cover



statistical findings of forest acreage, biomass, volume, growth, removals and mortality as well as discussions of specific Missouri issues.

*For more information:*

[Tom.Treiman@mdc.mo.gov](mailto:Tom.Treiman@mdc.mo.gov)

Moser, W.K.; Hansen, M.H.; Treiman, T.B. 2007. Missouri's forest resources, 2006. Research Note NRS-4. Newtown Square, PA: U.S. Department of Agriculture, Forest Service, Northern Research Station. 4 p.

United States Forest Service. 2007. Forest Inventory Data Online (FIDO). <http://199.128.173.26/fido/mastf/index.html>

## Timber Product Trends Report

*Project leaders:* Tom Treiman, John Tuttle (MDC)



*Objectives:* To track changes in timber prices (by product and species) from forester-assisted timber sales on both private and public land and report price trends to foresters, landowners and academics. This project continues every year.

*Summary of activities/findings this year:* At the end of each quarter (4 times a year), MDC and private foresters were contacted and asked to report volumes, prices and conditions of all timber sales they had assisted or conducted. Data was used to produce 4 short publications of quarterly price trends. Each publication also included updates on regional and national trends and issues affecting timber prices.

*For more information:*

[Tom.Treiman@mdc.mo.gov](mailto:Tom.Treiman@mdc.mo.gov)

Tuttle, J.; Treiman, T. 2007. Missouri Timber Price Trends. <http://mdc4.mdc.mo.gov/applications/MDCLibrary/MDCLibrary2.aspx?NodeID=854>

## Timber Product Output Survey

*Project leader:* Tom Treiman (MDC)

*Collaborators:* Jennifer Battson, (MDC), Julie Fleming (MDC), Ron Piva (USDA Forest Service), John Tuttle (MDC)

*Objectives:* To determine the volume of wood harvested and wood products from Missouri's forests to the county and species level, a census of all Missouri primary wood producers is conducted every three years and combined with data from surrounding states in cooperation with the USDA Forest Service.

*Summary of activities/findings this year:* MDC foresters visited (or attempted to visit) all Missouri primary wood producers in the spring of 2007. Mill owners/operators were asked to report mill, roundwood and product type(s), volume source (by county and species) and residue uses. Over 400



mills were contacted. RSD staff did data entry and MDC and Forest Service staff began data analysis. Based on this, a new 2007 Primary Wood Processors Directory was printed. In addition, a



searchable database was placed on MDC's public website.

*Plans for 2008:* MDC and the Forest Service will jointly produce a detailed analysis and summary of harvest pressure and production on Missouri lands.

*For more information:*

[Tom.Treiman@mdc.mo.gov](mailto:Tom.Treiman@mdc.mo.gov)

Tuttle, J.; Treiman, T.; Battson, J. 2007 Missouri Forest Industries. 2007 Directory of Primary Wood Processors.

<http://mdc4.mdc.mo.gov/Documents/373.pdf>

MDC 2007. Missouri Mills - Find a Wood Processing Mill.

<http://mdc4.mdc.mo.gov/applications/MOMills/MOMillsSearch.aspx>